Case Study: Modeling the Bundaberg Floods

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XP solutions

Bundaberg Case Study

- Burnett River Flood Events
- Flood Damage Impacts
- Surveying & LiDAR
- Current 2D Modelling & Applications
- Disaster Management – Modelling

- Acknowledgements
  - Bundaberg Regional Council
  - GHD
  - Bureau of Meteorology
  - ROAMES

Bundaberg Region

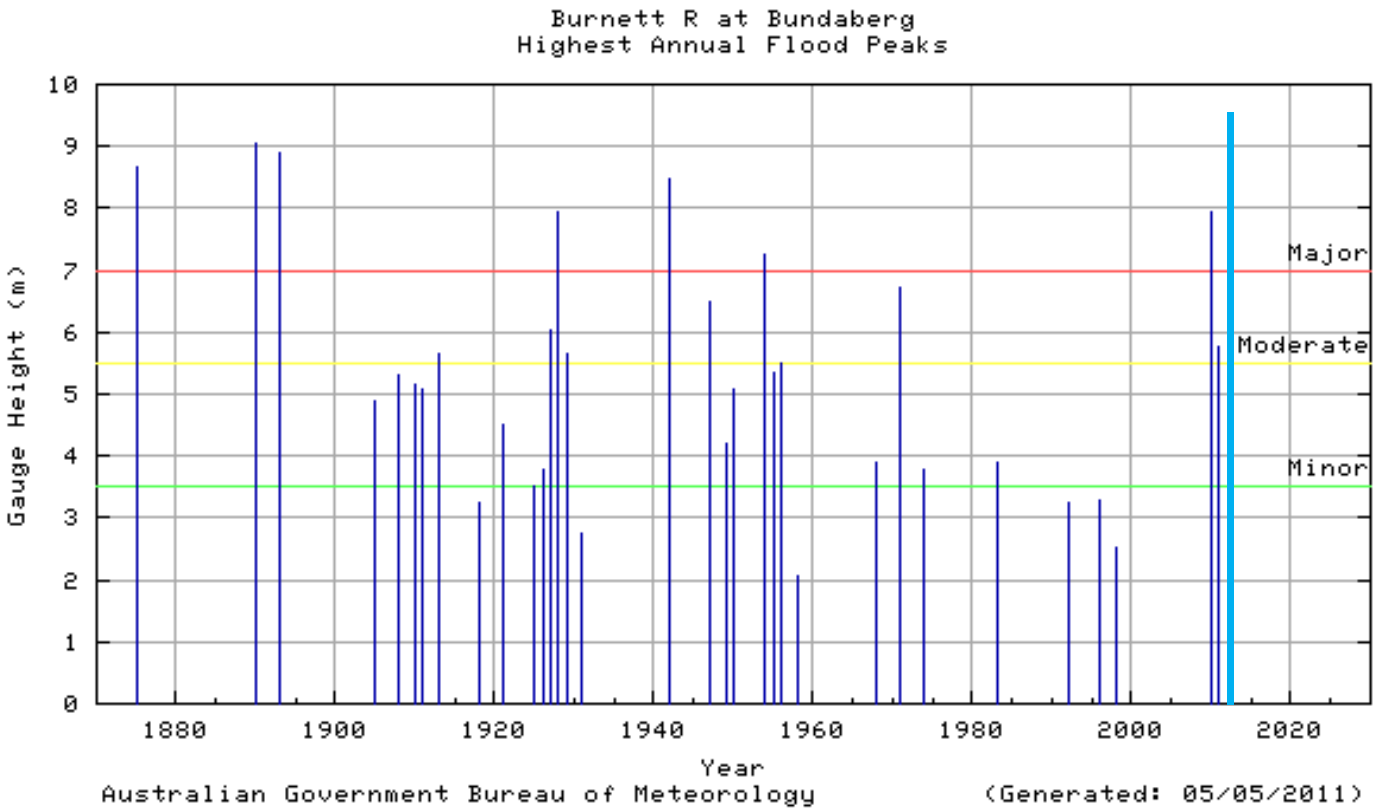
Population:	98,000
Projected 2031:	130,000
Area:	6,500 km^2
Asset Value:	$2.09 Billion
Annual Budget:	$206M

River Systems

- Significant number of sub basin outlets
  - **Burnett River**
  - Kolan River
  - Elliot River
  - Isis River
  - Gregory River
  - Burrum River
  - Baffle Creek

Historical Flood Events

- 1875
- *1890*
- 1893
- 1942
- 2010
- *2013*

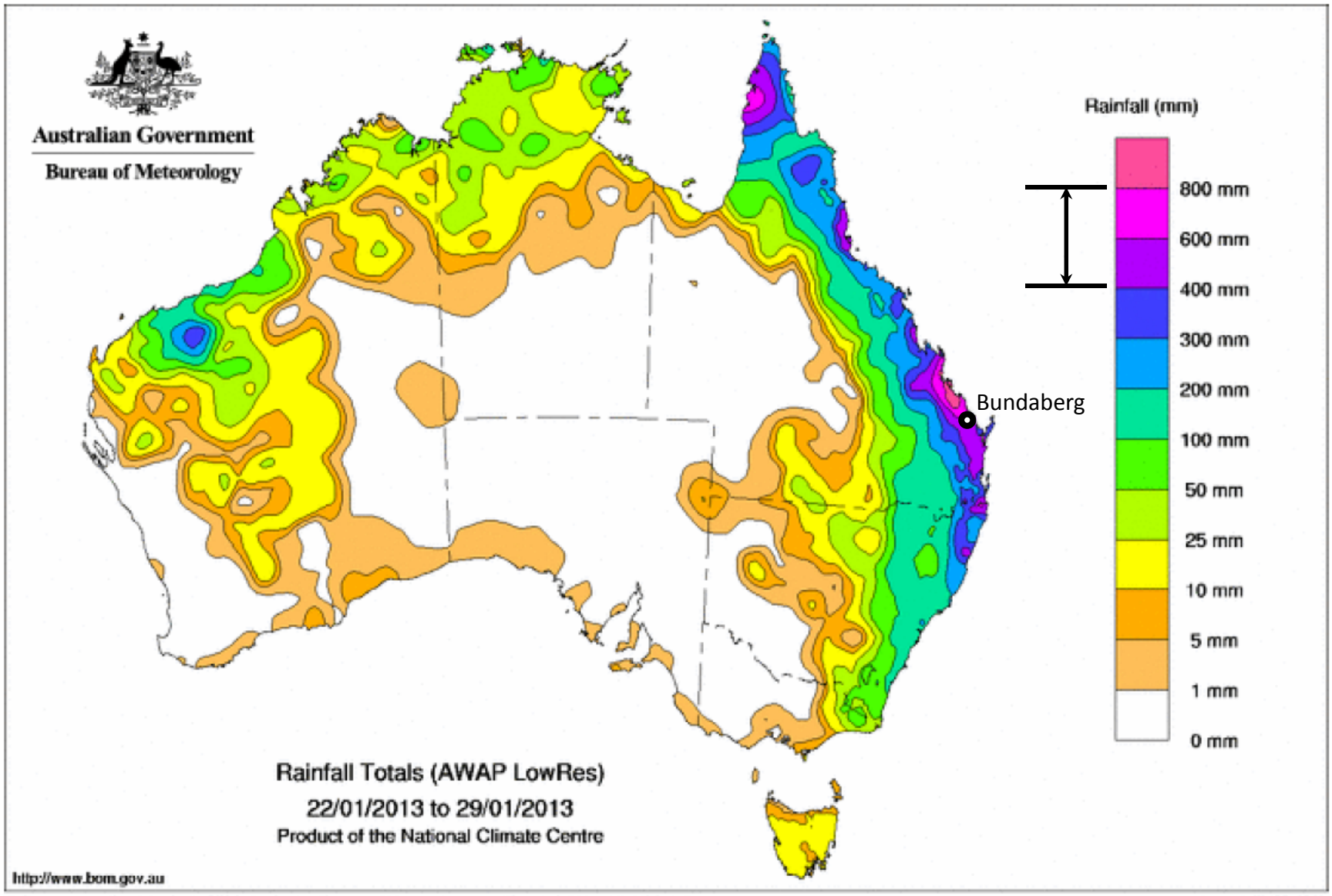


Burnett River

- Weeks of widespread rain on the Burnett catchment (33,248 km^2)
- December 29 2010, peaked at 7.92 m, largest since 1942
- Region was disaster declared, emergency crews activated
- 13th Jan 2011 the flood returned

26th January 2013

- 6 Tornadoes touched down on the coast
- By evening, torrential rain falling on the Burnett River catchment
- Flood Emergency Alerts Issued for Kolan River & Baffle Creek
- 1m Storm Surge predicted
- Ex- Tropical Cyclone Oswald tracked inland of Bundaberg



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New Meteorological Records

- Burnett Catchment Rainfall - **Average** of 206.8 millimetres for 27 January **exceeded** the **previous record** (123.6 millimetres) by nearly **70 per cent!!**
- Rainfall Totals - Highest records set for 2-, 3- and 4-day timescales by **large** margins
- Extreme daily rainfall across the catchment
  - Walla TM - **480mm** (**500yr** rain event)
  - Mt Rawdon – **549mm**
  - Bundaberg AP – **252mm**
- Gold Coast Hinterland **>700mm** daily rainfall!

27th January 2013

- Burnett River - Bundaberg
  - 5.5m @ 6:30am
  - 7.6m @ 4:00pm
  - BoM advised 8.5m overnight with higher peak expected
- Commenced **Voluntary Mass Evacuation** of North & East Bundaberg
- Swift Water Rescue operating

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28th January 2013

- 4:45am Burnett River exceeded 8.5m (>7m is serious) and rising!
- **Mandatory evacuations of North Bundaberg**
- Largest in QLD's history...
- 4 ADF blackhawks,4 Careflight, 2 AGL Rescue and 1 SLSQ helicopters
- Conservatively 5,500 in Nth Bundaberg, over 7,000 in the greater area
- At the peak approx 1,400 at evacuation centres


Twitter:
Commander Chris Hadfield
International Space Station
North Bundaberg
1 km


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29th January 2013

- Burnett River peaks at 9.53m at 3:15pm (0.5% AEP event 9.6m)

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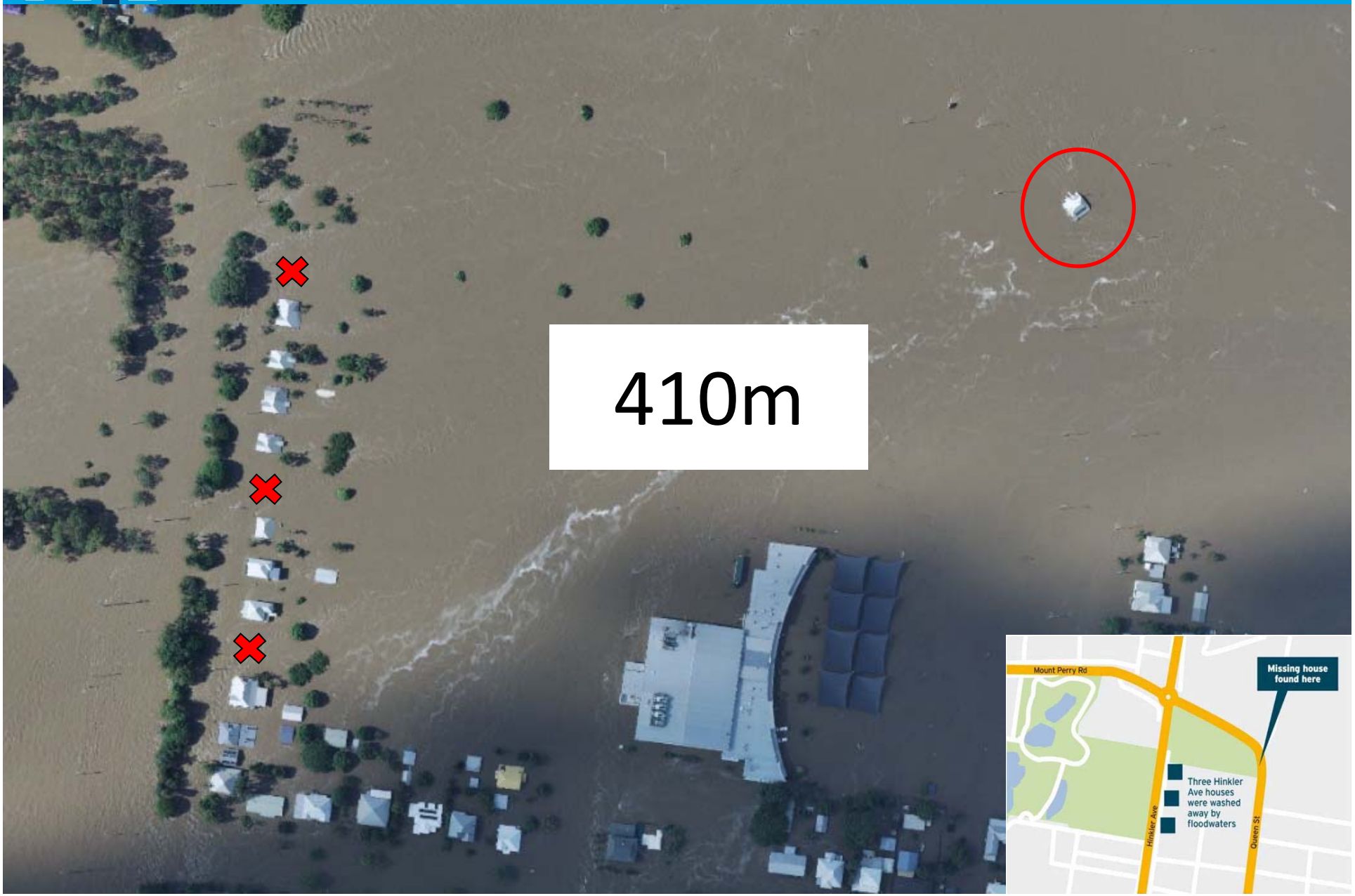
Relocation due to Buoyancy

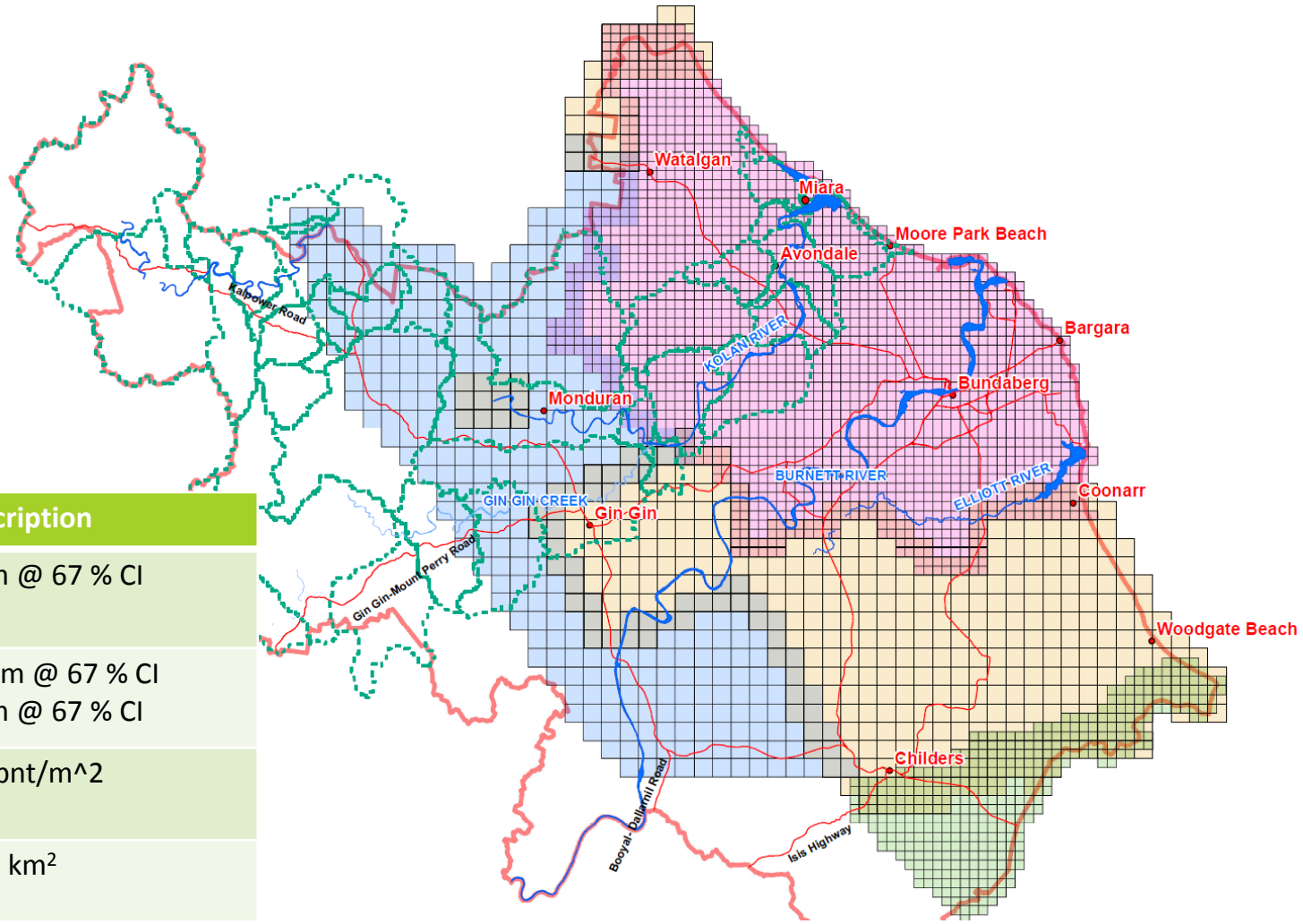



Scour Depths up to 2.5m
-1m
-0.9m
-2.3m
Gavin St
-2.3m
-1.9m
-1.9m
Wolca St
-1.2m
-1.9m

Flood Surveying

- Can't *Manage* what you don't *Measure*
- Opportunity to capture data:
  - **Flood Model Calibration**
  - Event Prediction
  - Disaster Management
  - Town Planning Controls

LiDAR Coverage



Over 4000 km^2

Field	Description
Spatial Accuracy (Hz) metres	0.3m @ 67 % CI
Spatial Accuracy (Vt) metres	0.15m @ 67 % CI 0.1m @ 67 % CI
Average Point Separation	1-4 pnt/m^2
Data Tile size (km^2)	1 - 4 km^2

LiDAR Coverage

- Over 65,000km2 across QLD
- Data is classified:
  - Ground (XYZ Ascii, Grid)
  - Water
  - Bare Earth
  - Above Ground
  - Classified LAS (Buildings etc)

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Roughness Map – Nested 2D Model

1:7,000 @A3
0 100 200
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Cadastre
- Nested 2D Hydraulic Model Boundary
- Blockages(Slab on ground building)

North Bundaberg Roughness (Manning's n)

- Open Grassland - 0.06
- Forest/Tree - 0.1
- Urban Lots (Yards) - 0.08
- Rail - 0.045
- Pavement - 0.02
- Road Reserve - 0.035
- Water Body - 0.03
- Raised Building Footprint - 0.15

GHD

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Bundaberg Regional Council
North Bundaberg

Job Number	41-24728
Revision	A
Date	09 Feb 20

Nested Model Extents and Roughness Map
North Bundaberg
Figure

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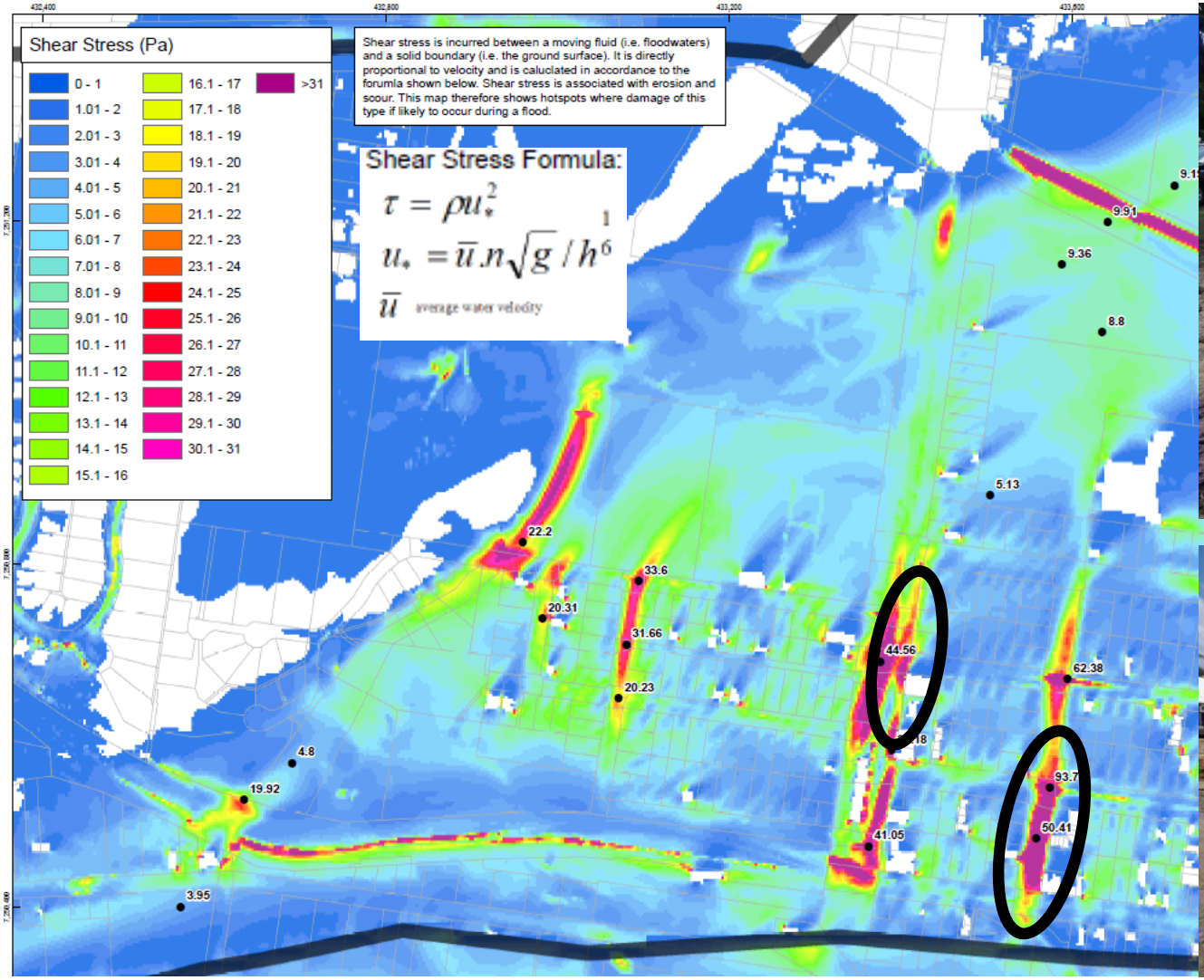
2D Modelling Importance

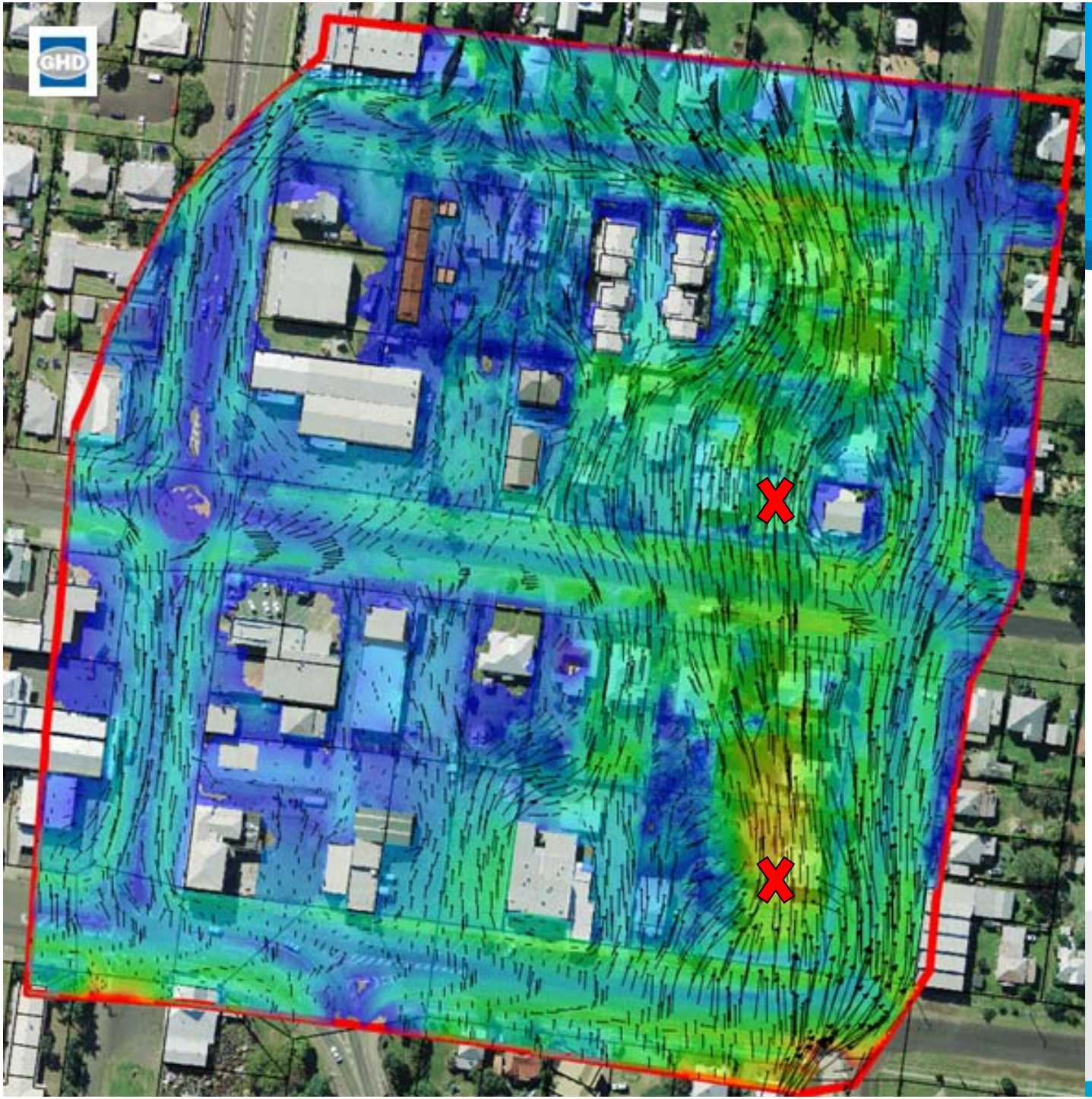
- Represent Complex flood behaviour up to PMF events:
  - Breakouts, bypasses and backwaters important for overtopping
- Flow characteristics such as level, depth, velocity, hazard and *shear stress.* 1D fails to distinguish spatial variation
- High-quality spatial datasets

2D Modelling & Scour

- Scour is the loss of soil by erosion due to water flow.
- *General scour* is the aggradation or degradation of sediment material not related to the presence of local flow obstacles.
- *Local Scour* is a term frequently used to describe the scour around obstacles that results from **increased local flow velocities (flow acceleration)**. It includes pier scour, abutment scour, and contraction scour.



Shear Stress - Flow force per unit ground area



Local 2D Hydraulic Model:

Velocity Vectors

&

Shear Stress Map

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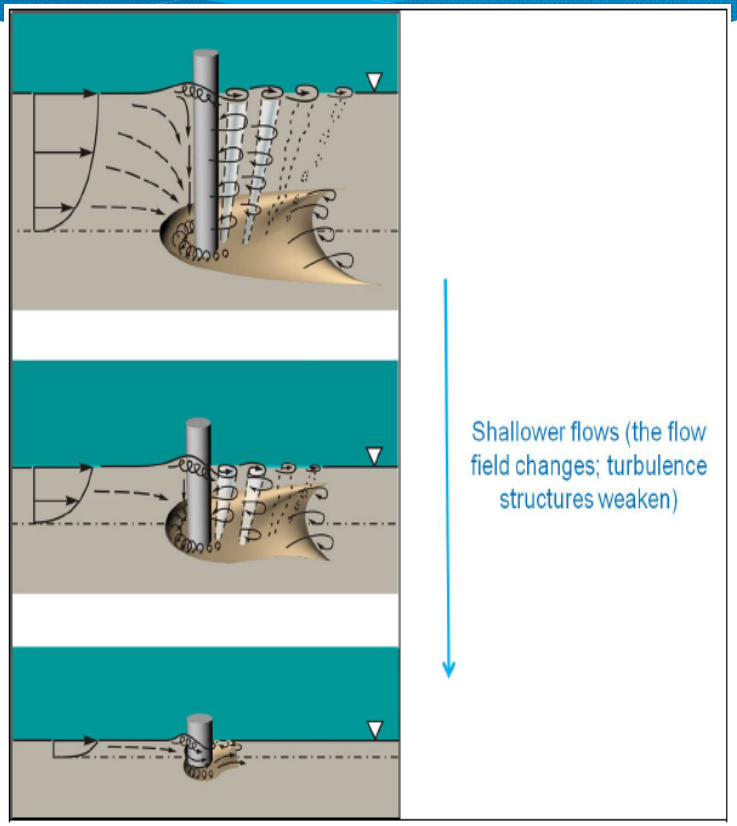
Structural Damage to Footings



Guideline for Improved Dwelling Resilience to Flood Induced Scour

Scour Risk Factor					
Foundation Condition Risk (from Table 4-2)	Flood Velocity Rating (From Table 5-1) m/s				
	1	2	3	4	5
	less than 0.3	0.3 to less than 0.5	0.5 to less than 1.0	1.0 to less than 1.5	1.5 to less than 2.25
Low	NIL	LOW	LOW	MED	HIGH
Mod S	LOW	MED	MED	HIGH	HIGH
Mod C	LOW	MED	MED	HIGH	HIGH
High	MED	MED	HIGH	EXTREME	EXTREME

Scour Risk Factor	Slab Details					
	D (mm)	d (mm)	Slab Reinforcement	Edge Beam	Cut Off Wall	Slab Joints
NIL	N/A	N/A	N/A	N/A	N/A	N/A
LOW	1200	100	SL72min	Yes	--	Type & locations to Engineer's detail
MED	1500	100	SL72min	Yes	--	Type & locations to Engineer's detail
HIGH	1800	100	SL72min	--	YES	Type & locations to Engineer's detail
EXTREME	2100	100	SL72min	--	YES	Type & locations to Engineer's detail

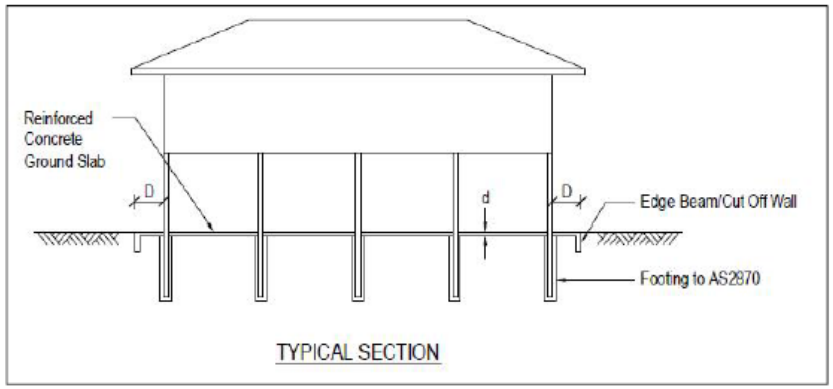


Figure 1.0 Typical Section

Typical details pertaining to the cut off walls, edge beams and post / stump trimming details are indicated in figures 3.0, 4.0 and 5.0 below:

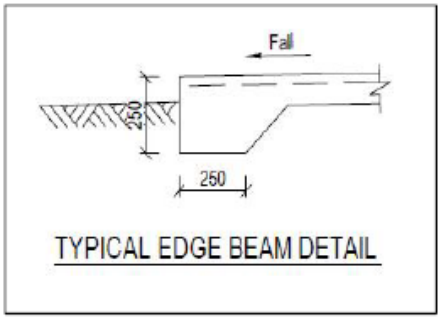


Figure 3.0 Typical Edge Beam Detail

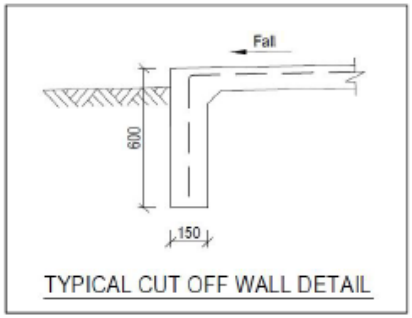


Figure 4.0 Typical Cut Off Wall Detail

Model Outputs

- River flows, flood levels, river velocities and hazard indices for defined flood events *to PMF*
- Map the subject areas:
  - Urban areas - flood level contour (0.1 m)
  - Non urban areas – flood level contour (0.25 m)
  - Hazard, Depth, Velocity, Time to Peak,

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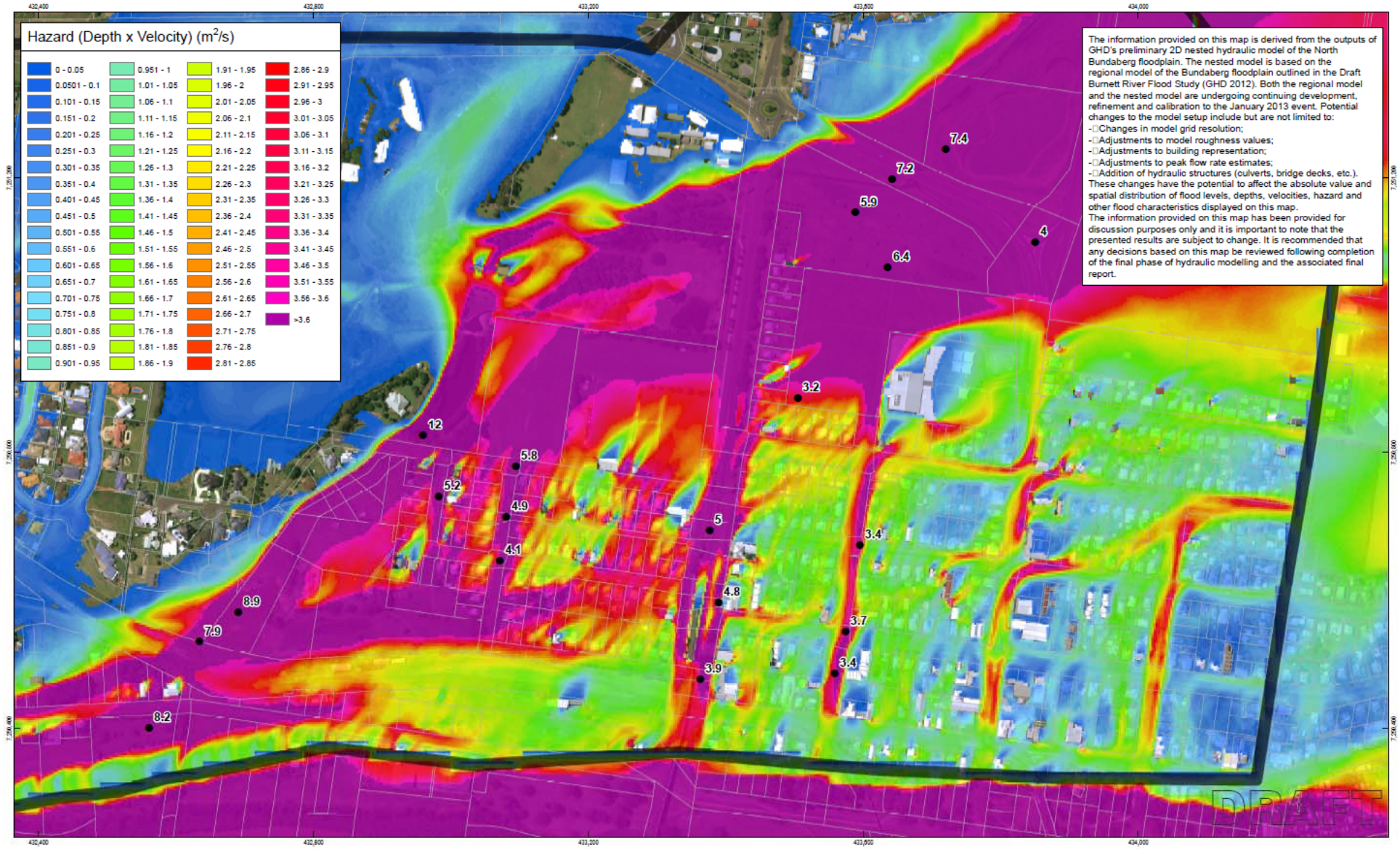

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Nested Velocity (m/s)
0 - 0.21
0.22 - 0.42
0.43 - 0.63
0.64 - 0.84
0.85 - 1.05
1.06 - 1.25
1.26 - 1.46
1.47 - 1.67
1.68 - 1.88
1.89 - 2.09
2.1 - 2.3
2.31 - 2.51
2.52 - 2.72
2.73 - 2.93
2.94 - 3.14
3.15 - 3.34
3.35 - 3.55
>3.55
The information provided on this map is derived from the outputs of GHD's preliminary 2D nested hydraulic model of the North Bundaberg floodplain. The nested model is based on the regional model of the Bundaberg floodplain outlined in the Draft Burnett River Flood Study (GHD 2012). Both the regional model and the nested model are undergoing continuing development, refinement and calibration to the January 2013 event. Potential changes to the model setup include but are not limited to:
-Changes in model grid resolution;
-Adjustments to model roughness values;
-Adjustments to building representation;
-Adjustments to peak flow rate estimates;
-Addition of hydraulic structures (culverts, bridge decks, etc.).
These changes have the potential to affect the absolute value and spatial distribution of flood levels, depths, velocities, hazard and other flood characteristics displayed on this map.
The information provided on this map has been provided for discussion purposes only and it is important to note that the presented results are subject to change. It is recommended that any decisions based on this map be reviewed following completion of the final phase of hydraulic modelling and the associated final report.
1.58
1.61
1.53
2.87
1.51
1.07
2.54
2.74
2.12
2.59
2.96
3.22
2.08
2.7
1.22
3.78
2.2
3
2.86
1.09
DRAFT


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Emergency Management Maps

- Assessment of **evacuation routes**, **population-at-risk investigations**, **time-of-inundation** and **duration-of-inundation**, and **flood damages estimation**.
- 2D Model generates a series of **flood surfaces** for a *range* of flow rates or *Gauge Heights*

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January, 2013 Event (Calibrated Flood Model vs Actual)

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Key Learnings

- Model the **full range of events**, don't just consider planning instruments
- Where possible undertake 2D Modelling on ***entire*** catchment, especially where rural residential exists.
- Understand the relationship between flood levels ***and*** river gauges, especially for population density;
- Ensure the **spatial data** is **key deliverable** of any flood study;
- Undertake **Floor Level Surveys** for residential dwellings – it **saves lives**
- Incremental flood **maps tied to river gauges** (not Design Events) are essential during emergencies